DOCUMENT RESUME

ED 272 190 IR 012 317

AUTHOR	Deck, Dennis; Coe, Merilyn
TITLE	Linking Microcomputers to Share Educational Data. Evaluation Guides. Guide Number 21.
INSTITUTION	Northwest Regional Educational Lab., Portland, Oreg.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	[85]
CONTRACT	400-80-0105
NOTE	25p.; A product of the Research on Evaluation Program.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Case Studies; Computer Networks; Computer Software; *Computer Uses in Education; Databases; Elementary Secondary Education; Evaluators; *Information Networks; Information Utilization; *Microcomputers; *Telecommunications
IDENTIFIERS	*Computer Communication; Modems

ABSTRACT

Designed for educational evaluators, this paper discusses reasons for the growing concern with linking or interfacing computers for information sharing; compares three major approaches to linking; and discusses the implications of each. An initial overview presents three linking applications in educational evaluation: (1) linking microcomputers with mainframes for data analysis; (2) data collection; and (3) distribution of instructional information systems. Scenarios are also provided which illustrate each of the three applications. The three major technical approaches to linking microcomputers with mainframes or each other are then described--exchanging electronic media (floppy disk exchange); telecommunications linkages, including asynchronous and synchronous connections; and linking products (software packages). Examples and implications of each approach are discussed, including their advantages and disadvantages. Alternatives to shared access to a large database, such as local area networks and multi-user microcomputers, are also described, and their advantages and disadvantages outlined. Finally, the problems of coordination and system design are addressed; it is noted that finding solutions to linking problems takes time and experimentation, and that computer resources cannot be maximized without user acceptance. The latter necessitates the involvement of users in each stage of the planning, design, and testing of the application. Six examples of evaluation linking applications that are being implemented conclude the document, and a list of references is provided. (JB)

EVALUATION GUIDES

Guide Number 21

LINKING MICROCOMPUTERS TO SHARE EDUCATIONAL DATA

Dennis Deck
Merilyn Coe

Applications of computer linking are discussed, including

- Definition and Overview
- Range of Application
  - Exchanging electronic media
  - Telecommunication linkages
  - Local area network
- Implications of each application
- General guidelines for appropriate choices
- Summary

Research on Evaluation Program Nick L. Smith, Director

Northwest Regional Educational Laboratory
300 S.W. Sixth Avenue • Portland, Oregon 97204 • Telephone (503) 248-6800

The increase in the use of microcomputers during the past five years has been a primary contributor to bringing us into the information age. Microcomputers are being designed to handle more and more information. It does not take long, however, for the microcomputer user to begin to want data that is on someone else's computer, or for someone to begin to request data that you have on yours.

One of the tenets of the current effective schools movement is that instructional methods based on clear, explicit objectives and continuous monitoring of progress has been most effective. These methods are difficult to implement without a good recordkeeping system on computers, one which is continually updated and can provide immediate answers to questions. Hathaway (1985) argues for distributed information systems where data are generated, maintained, and used primarily at the classroom level and relevant data can be sent for use at higher levels. This promotes a feeling of ownership and a perception of usefulness.

This paper discusses some of the reasons why evaluators have become so concerned with linking computers. It compares three major approaches to linking and discusses the implications of each approach. The intent is to provoke thought about linking: why link, and what options are available. This paper is not a technical guide. The intended audience is the educational evaluator, at the district or state level, not the data processing professional.

I. LINKING APPLICATIONS IN EDUCATIONAL EVALUATION: OVERVIEW AND APPLICATIONS

One of the striking results of a national survey on the uses of computers in educational evaluation was the demand for linking or interfacing computers (Coe, 1985). The respondents, who represented state and local district research and evaluation units, primarily wanted to link microcomputers with mainframes for data analysis. Access to large data bases and eliminating the need to rekey data that existed on the other computer were the main reasons given. Evaluators found the mainframe necessary to maintain large, centralized databases and to conduct statistical analyses with packages like SPSS. They felt microcomputers provided more control, had less waiting time, offered unique software and were easy to use. One could capitalize on the advantages of each resource if the two forms could interact.

A second application of interfacing is data collection. Rather than ask the respondents to complete paper forms, another option is to enter the data directly into a computer. A microcomputer can act as a terminal. Since the respondents typically have microcomputers rather than mainframe terminals, interfacing is again an issue. Not only does this eliminate keypunching, but there are opportunities for controlling the quality of the data entered and hopefully allowing the user to use the data as well.

A third emerging application is distributing instructional information systems. Objective-referenced instructional models require much testing and recordkeeping, ideal tasks for small computers. But since student progress data is generated and used at the classroom or school level, it makes sense to store the data near its source. Therefore, data collected on microcomputers will be transferred to the mainframe and summaries returned to district administrators and evaluators. The problem is linking the microcomputers at the school site.

Consider three scenarios, each based on an actual situation, in which linking computers will assist in distributing information for instructional and evaluation purposes. These scenarios were selected to illustrate each of the above applications.

Application I: Survey Analysis

A researcher in a moderate sized urban school district has been charged with conducting a drug and alcohol abuse survey on 6,000 students. The survey is prepared with separate answer sheets so it can be scanned with an optical mark reader attached to an IBM PC (microcomputer). The researcher plans to purchase computer time from a nearby university to analyze the results with the Statistical Package for the Social Sciences (SPSS) (mainframe). The researcher plans to take advantage of the excellent spreadsheet and graphics programs on the microcomputer to prepare tables and charts for the final report from summary data produced by SPSS (mainframe). The report will be written with a wordprocessing program (microcomputer), but the final editing and printing will be done on a large wordprocessing system (mainframe).

This scenario requires extensive use of both types of computer systems, and the researcher will greatly improve productivity if personal microcomputers and mainframes are linked. Each machine provides unique capabilities that can best be tapped by a means of easily transferring data back and forth. Raw data files from the scanner should be uploaded to the mainframe rather than keypunching the answer sheets as is often done. Summary data from SPSS should be downloaded to the microcomputer so the researcher need not reenter the data, a time consuming and error prone process. The draft report should be transferred to wordprocessing system rather than retyped.

Because there is little reason to purchase an expensive terminal to the mainframe when the personal computer can be upgraded to serve the same function, the district can save money on capital purchases.

Application II: Data Collection System

This state department of education collects information twice a year about school district staff. The district must complete a mark sense form that can be optically scanned. A statewide staffing database is updated with these data. However, quality control problems with the completed forms and complaints from districts about the difficulty of coding text fields like teacher name have prompted the state to consider other ways to collect the data. Since virtually all of the districts have access to either an Apple II or IBM PC microcomputer, the state plans to feature these two machines in the new data collection system. In addition, some districts have requested summary data back since the data flow is only upward.

In this scenario, the state can improve data quality by controlling data entry with a computer program which is more effective than simply including a manual of instructions that no one will read when paper forms are used. Inaccuracy of data entry is minimized since the user enters the data directly.

Perhaps the most important advantage of linking in this example is that there are new opportunities for making the data more useful to those providing the information. Depending on the software used, the district may be able to keep a copy of the data for local use. The district can have access to summary or historical data. This marks a shift away from the usual "data up, decisions down" approach to educational data collection and should increase user acceptance and commitment.

Application III: Instructional Information System

An evaluation office plans to establish a student data base that maintains standardized test scores, criterion referenced test scores, and general progress on the district goals and objectives. Aides and secretaries will enter data collected at the school level while the standardized test scores, which are scored by the district testing office, will be available from the district mainframe. Principals, teachers and counselors need to access up-to-date information on individuals or student groups. District administrators and evaluators need to access summary information and may wish to do further analyses with spreadsheets or other microcomputer software.

The scenario requires that several users have ready access to a single, shared database at the school site, but that data are also available to district staff. Test and objective mastery information are in daily use. Most of the student level information originates and is used primarily within the school. In contrast, summary data are transferred to the district and standardized test results are transferred to the school infrequently. Thus a high performance, tightly linked system is needed strongly within the school site but not necessarily between the school and district office.

II. APPROACHES TO LINKING MICROCOMPUTERS

This section describes the three major technical approaches to linking microcomputers with mainframes or each other. The three options are: exchanging electronic media (floppy disk exchange), synchronous telecommunication and asynchronous telecommunications. Examples and implications of each approach are discussed. Other references and communications specialists should be consulted for more detailed information.

A. EXCHANGING ELECTRONIC MEDIA

Virtually all computers have some external storage medium that is transportable and relatively compatible with different vendors' equipment. Among mainframes, magnetic tapes may be written on one system and read on another system, usually without much difficulty. Among most desktop computers, the 5 1/4 inch floppy disk may be exchanged.

As Figure 1 shows, the procedures are simple. School A staff, who originate the data, makes a copy of their data disk and send it by district mail to the department requesting it. District staff read the disk on their microcomputer. Very often, however, someone ultimately wants to use the data on a mainframe or another microcomputer that cannot read that disk. Then there must also be a communications link to the mainframe. Consider the following educational applications.

Examples:

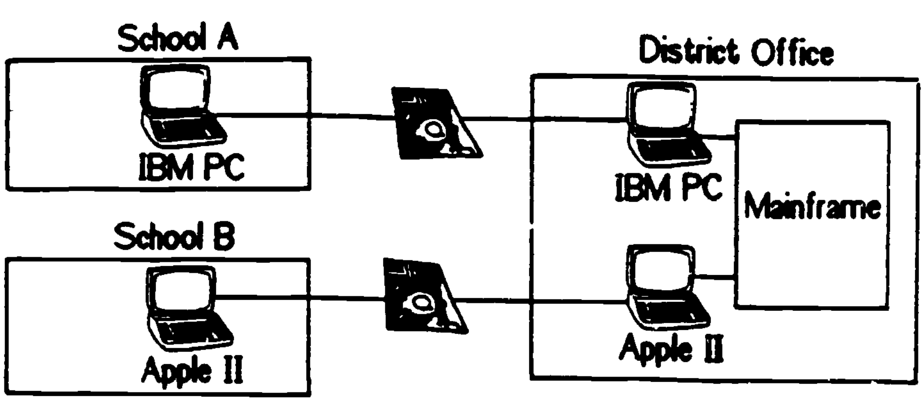
The evaluator of the Chapter 1 program for the Sacramento City Unified School District collects data about student service directly from the classroom teachers using a simple data base program on Apple II computers. Since the evaluation analysis is conducted on an IBM PC, a special adaptor card was purchased to read Apple disks and to convert them to IBM format.

A school district in Arizona implemented a student database using Apple IIs with a CP/M card and a 10 megabyte hard disk in each school (Moscow, 82). Rather than use expensive telecommunications to link schools to the district mainframe, floppy disks are sent to the district office through the district courrier with any update information. One Apple at the district office is connected to the mainframe to update the districtwide database. This represents the "data-up" side with no corresponding development of "data-down" opportunities.

The California Department of Education (CDE) maintains the California Basic Education Data System (CBEDS) to collect teacher records and other school level data (California State Department of Education, 84). While schools can complete a set of forms, they have the option to send magnetic tapes written to certain specifications or to enter the data on either Apple or IBM floppy disks. The latter option is of most interest to us here. A database program is provided on the disk to guide data entry by district staff. The disks are sent to Sacramento where state staff read the disks on an Apple or IBM and telecommunicate the data to the mainframe. Currently the department is also experimenting with sending historical summary data gleaned from several files on the Sacramento mainframe back to districts on floppy disk.

CTB/McGraw Hill, publisher of several standardized tests, now provides student objective mastery data on floppy as one option in their scoring service. The management system they market also includes prescribed activities on disk that can be matched to student performance on these objectives.

Figure 1. Example of exchanging floppy disks.



Implications

While the floppy disk represents the simplest means of transporting data, it is often overlooked in favor of more glamorous, state-of-the-art methods. This section outlines the advantages and limitations that must be considered.

7

Advantages:

- Inexpensive. Assuming that each user's computer has at least two disk drives, this approach requires no extra hardware for each user's computer. Some hardware is often needed to link the central site microcomputer to incompatible computers, but the cost ($300 - $1,500) is only incurred for one workstation.

- Little user training needed. The procedures for making copies of disks are simple and require little or no user training. The more complicated procedures for transferring data to the mainframe are centralized.

- Simple installation. Except for linking the computer at the central site to a mainframe or other computers, no installation is required.

- Reliability. There is very little to go wrong in transferring disks compared to approaches using telecommunications.

Disadvantages

- Timely data. The most problematic effect of using floppy disks is that access to the remote data is not immediate. The user must wait for a day or several days for the disk to arrive.

- Multiple disk formats. Most microcomputers use 5 1/4 inch floppy disks but different computer brands format the disks in incompatible ways. The solution is to purchase a disk utility that can control one of the disk drives into emulating the drive from another computer. For example, the Uniform utility program for IBM PCs converts disks from CP/M computers to IBM format. In the case of Apple disks, a hardware solution is needed. For instance, the Apple Turnover Card causes one of the drives on an IBM PC to emulate an Apple II drive so that files can be copied to an IBM formatted disk in the other drive. As the 3 1/2 inch floppy disk drives become more popular, other solutions will be needed.

  A similar problem is the use of different operating systems on one brand of computer. An Apple IIe may run either DOS 3.3 or PRODOS but disks created one operating system are incompatible with the other. PRODOS does provide a utility program to convert DOS disks to PRODOS.

There are three different versions of MSDOS for the IBM PC. Each version supports disks with a higher density of data. For example, MSDOS 1 can write 320 Kilobytes on a disk while MSDOS 2 can write 360 Kilobytes on a disk as well as read MSDOS 1 disks.

- Disk problems. Occasionally a disk cannot be read. This is usually due to a disk drive that is out of alignment, the originating computer may be able to read the disk but the receiving computer cannot. In rare instances, the disk will be physically damaged in the mail or courrier route.

- Disk capacity. An Apple II disk store about 130 Kilobytes (equivalent to about 43 single spaced pages) and an IBM disk can store about 360 Kilobytes (120 pages of text). This is more than enough for simple applications but inadequate for many.

B. TELECOMMUNICATION LINKAGES

When people speak of interfacing computers, they usually mean linking microcomputers to mainframes using telecommunication. In telecommunications, hardware and software are used to make the microcomputer act as a terminal attached to the host computer. Typically, the host is some distance away and standard phone lines must be used to make the connection. Since phone lines cannot carry the signal coming from the computer, a modem is used at each end to modulate the signal.

There are actually two levels of sophistication in telecommunications. At the simplest level, microcomputers use slow speed asychronous communications. A second level, a more sophisticated link would use high speed but costly synchronous communications.

Finally, software linking products can be used to make communications more functional. A brief overview of each level is given below. See Kruglinski (1985) or Jordon and Churchill (1983) for a more detailed discussion of telecommunications.

In each of the previous senarios, a micro-mainframe link is required. In the drug and alcohol study, the researcher must transfer to and from the mainframe. The state data collection system may be based on floppy disks but the data must be transferred to the mainframe. The instructional information system has an autonomous function at the school level but some data must still be transferred between the district mainframe and the school's system.

1. Asynchronous Connection

The simplest form and oldest of communications between computers is known as asynchronous. Many mainframe computers and virtually all microcomputers support it.

As Figure 2 shows, the asynchronous communications adaptor, usually called a serial port, of each computer is connected to a modem which modulates the signal that can pass over standard phone lines. Characters are usually transmitted at 30 to 120 characters per second, relatively slow by today's standards, though faster speeds are possible when computers are connected directly. Faster modems that can still be used on standard phone lines are appearing on the market.

The communications software simply sends characters from the keyboard or from a disk file to the modem and displays characters coming from the modem transmitted by the remote computer. Some of the features these programs provide are:

- ability to reconfigure the speed and other characteristics to match the host computer
- directory of phone numbers for different host computers
- access a file from the disk and send to the host computer
- receive data from the host computer and save it to the disk
- special file transfer protocal that provides error checking of the data and resends any block of data in which transmission errors were detected

Implications

Advantages:

- Inexpensive. Each user's computer must have a serial adaptor, a modem, a cable connecting the serial adaptor and modem, and a communications program. The costs are:

Serial adaptor	$100
Modem	$100-500
Cable	$ 45
Software	$ 50-250
Total	$295-895

- Simplicity. Compared to synchoronous communications, asynchronous is simple to install and maintain. Some expertise in computers is needed to setup asynchronous communications but the district would not need a data communications expert.

Disadvantages:

- Slow speed. Although 2400 bps (bits per second) modems have recently become available, asynchronous communication typically occurs at 300 bps or 1200 bps, which is equivalent to 30 and 120 characters per second, respectively. While 120 cps is faster than a good typist, it would take 5 minutes or more to send just 10 pages of text.

- Transmission errors. The standard phone line is prone to static and other noise that can corrupt any data transmitted. In a word processing document, the errors would look like typing or spelling errors. In transmitting the results of a competency test, however, the errors could mean the difference between graduation and non-graduation. Expensive conditioned phone lines may help but do not solve the problem. Many communication programs support special file transfer protocals like Xmodem, which is available on most microcomputer programs, or Kermit, which is a public domain program available for some mini- and mainframe computers as well as many microcomputers. However, both the sending and receiving computer must support the same protocal. Two new protocals, MNP from Microcom and X.PC from Tymnet, are offering faster transmission and more reliable error checking, particularly with the new 2400 bps modems.

2. Synchronous Connection

In synchronous communications, a block of characters is sent at high speed in a packet containing block identification and error checking informaton. Some form of synchronous communications is used with most mainframes and much application software has been written specifically for this environment. Many IBM mainframe installations provide little or no support for asynchronous communications.

The primary type of synchronous terminal used to access an IBM mainframe is from the IBM 3270 family of terminals. As Figure 3 shows, these terminals are connected to a 3274 Cluster Controller which is connected to the mainframe. Modems and phone lines are needed if the terminals are located at a remote site, but these are different from those used in asychronous

Figure 2. Example of asynchronous communications.

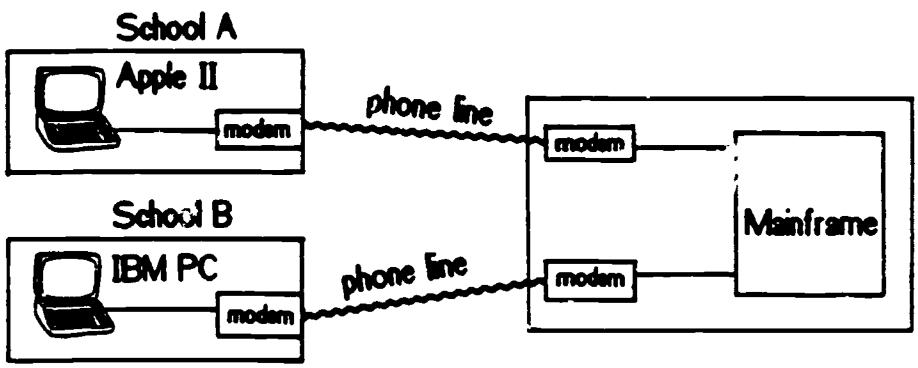
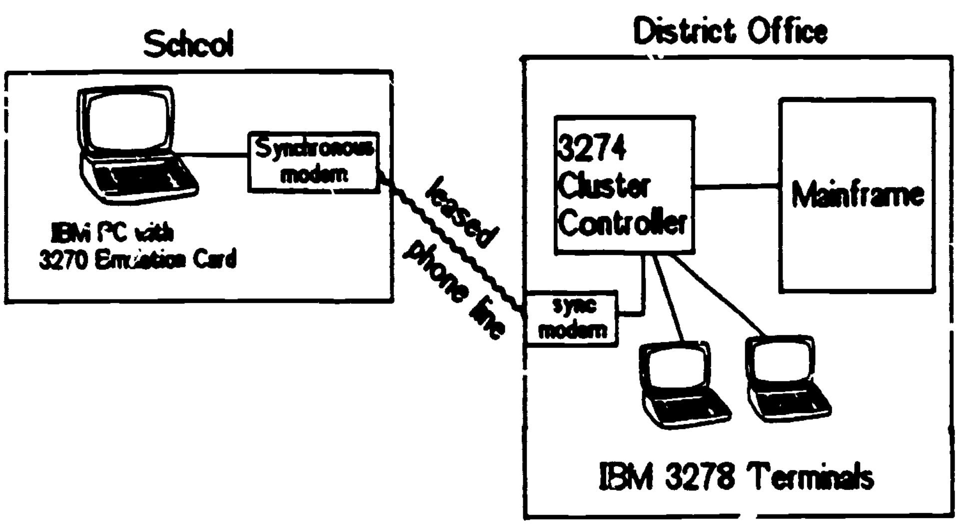


Figure 3. Example of synchronous communications.



communications. The more complex synchronous modems operate at speeds from 2,400 bps to 56,000 bps over special leased phone lines. The terminal sends a screenful of data at a time to the mainframe with a protocol that provides automatic error checking and error correction.

To make a microcomputer emulate a 3270 terminal requires an adaptor card which is connected to the cluster controller or to a synchronous modem. Special software makes the computer act like the 3270 terminal. For example, the IBM PC lacks the 24 programmed function keys of a 3270 terminal so the software must determine which key sequences will be used to handle the 3270 functions. However, this upgrade to an IBM PC costs much less than purchasing a 3270 terminal. Also, when not communicating with the mainframe the PC functions normally as a standalone microcomputer. There are many possible combinations of emulation cards and communications equipment. See Kruglinski (1985) or Krumrey (1985) for a discussion of configurations on 3270 emulation.

Implications

Advantages:

- Costs. The adaptor cards with emulation software cost about $1,000 to $1,500 each. A 4,800 bps synchronous modem runs about $1,700. The high speed leased telephone line (local channel) is a major continuing expense at approximately $70 per month, with a one-time installation charge of about $300. There are a number of hardware solutions to reduce costs when more than one computer is being used.

Disadvantages:

- Software. Unless users spend considerable time on the computer, they find mainframe software difficult to use. The layers of software, unfriendly mainframe software, and the maze of commands and options conspire to make the novice or casual user unhappy.

- Incompatible data structures. The data structures used with mainframe software are often incompatible with those for microcomputer software like Lotus 1-2-3 or dBASE III. Deck (1985) surveyed data structures that are compatible with popular software for the IBM PC and Apple II. From this study, three formats are recommended for exchanging data.

- Connecting non-IBM computers. At the building level, Apple II, TRS-80 Model III, and Commodore computers are more commonly found than IBM PC compatible computers. It is difficult to find 3270 adaptors and software for these machines compared to IBM microcomputers.

- Data processing support. Installing and maintaining 3270 emulation will require professional assistance from the data processing staff. The data processing department may have a backlog of competing tasks or concerns about control and security.

3. Linking Products

Once the communications link has been established, there is still a major software problem in transferring data. First, the structure of files on the mainframe will likely be incompatible with those required for particular programs on the micro. Second, the user must know how to use utility programs to make the file transfer.

To solve these problems, new software packages have recently appeared on the market known as "linking products". These packages run on both the mainframe and the microcomputer to facilitate moving data between the two machines. For example, PC/Focus is a database management package for the IBM XT that works with the mainframe FOCUS database (Sirota, 1985). The user can move data freely to and from the mainframe and microcomputer Focus databases. The procedure to query the mainframe database is identical to that for the microcomputer database. The program even includes statistical functions for the evaluator.

GOLDENGATE from Cullinet is another linking product (Catching, 1984). The microcomputer package integrates a relational database manager, a spreadsheet, a word processor, a graphics program, and a communications program. The Information Database accesses databases, particularly Cullinet's IDMS/R, on IBM mainframes. The user can work with GOLDENGATE files on the microcomputer or access the mainframe and work with files on both computers.

Implications

Advantages:

- Ease of use. The communications link and mainframe operation, which can be intimidating to the non-technical user, are quite straightforward with linking products. The user can easily work with both mainframe and microcomputer files at the same time, concentrating on answering the questions at hand rather than on following awkward procedures for moving data between the computers.

- Security. These programs allow for various levels of security to keep unauthorized users out of sensitive data like salary files.

Disadvantages:

- Too demanding for casual user. [These programs are rich in features and necessarily take some time to learn. They are more appropriate for the professional who spends considerable time on the computer than for the casual user.]

- Cost. Software linking products come with a high price tag, especially since the user has already spent quite a bit on communications hardware. The mainframe version of Focus costs over $110,000 and each copy of Focus/PC costs $1595. The GOLDENGATE package costs $795 per copy and the Information Database linking program costs $75,000.

1. CONNECTING MICROCOMPUTERS LOCALLY

While it is possible to send a floppy disk or to link a number of PCs operating on 3270 terminals at a school site to a district mainframe, it is sometimes preferable to link microcomputer terminals to hard disk storage and printers within the local site. Local area networks and multi-user microcomputers can provide some of the benefits of shared access to a large database at lower cost and offer greater local control than available with the transfer of electronic media.

1. Local Area Networks

A local area network (LAN) links similar computers that are located in relatively close proximity. The network usually provides access to at least one shared hard disk drive, to a high speed printer (and other expensive peripheral devices), and to a communications link to other networks or mainframes.

Although types of networks and configuration can vary considerably, Figure 4 shows a typical LAN. Each personal computer has a network adaptor card that is connected to the main network cable or bus. One or more hard disk drives that can be accessed from each personal computer are attached to a disk network server. Although individual computers may have inexpensive dot matrix printers attached, this system allows for the sharing of expensive high speed or letter quality printers. If a modem is also attached to the network, any computer on the network can use it to access other remote computers.

The main reasons supporting the application of a network are: sharing data files, sharing expensive resources like hard disk storage and laser printers, sharing software, and electonic mail. In educational settings only the first and last, data sharing and electronic mail, seem to justify the costs and problems.

Network technology is relatively young and changing rapidly. Jordan and Churchill (1983) provide an overview. Piele (1985) and Spain (1984) discuss networking in instructional settings. Computer trade journals are continually reviewing the state of the art in networking (P. C. World, 1985, P. C. Magazine, 1985).

Educational Applications

There are few published descriptions of network applications in educational evaluation. School network installations have been reported for computer assisted instruction and/or administrative functions. The small district in Banks, Oregon, installed a network with an IBM XT network disk server and four Compaq workstations (Piele, 1985). Word processing documents and spreadsheet budget files are shared between secretaries and administrators. A database program is used to format data files that are transferred to a statewide educational data processing agency in another city.

Implications:

Advantages:

- User friendliness. Compared to a stand alone microcomputer, the network is a little more difficult to use, but the speed of exchange is a definite asset.

Disadvantages:

- Cost. The additional hardware to attach a microcomputer to a network costs at least $1,000 per computer. With the disk and printer servers and other hardware costs, the total cost can be as much as $4,000 over the purchase price of each microcomputer (Ferris & Cunningham, 1984). One of the main hidden costs in installing a network is laying in the cable, since the workstations will likely be in different parts of the building. In rambling school buildings this could account for quite an extensive outlay.

- Software licenses. Nearly all microcomputer business software packages like database management or spreadsheets are licensed for a single computer and a single user. Thus it is simply illegal to operate such software on a network, often eliminating software sharing as an advantage of networks since a copy must be purchased for each computer. Network licenses are just now appearing for a few packages like SuperCalc 3 and Multimate (Mace, 1985) The copy protection schemes that publishers use to keep users honest also cause problems since they usually prevent the program from being loaded on the network's hard disk.

- Limited multi-user access. The promise of many users accessing the same student database at the same time is rarely met in practice. Only a few database packages have been written to support open records generally locks the package of other users from a student's record until the first user is done editing the record, even if the LAN supports it.

- Need for network management. Piele (1985) reports that planning, installing, and maintaining networks in educational settings requires a network manager to solve the new problems caused by the network, even when users are experienced with microcomputers.

? Alternatives

A primary alternative to a local area network of microcomputers is to install a multi-user microcomputer or supermicro. If more than 4 to 8 workstations were needed, a minicomputer may be more appropriate. As Figure 5 shows, there is a central processing unit with hard disk storage and printers attached. Instead of personal computers, inexpensive dumb terminals with just a keyboard and screen serve as workstations. A minimum configuration might be an IBM AT with a 20 megabyte hard disk and one or two terminals.

An example of this application is the Christina School District in Delaware. It has been operating a multiuser information system that includes an instructional management system based on a mastery testing program (Idstein, 1985, Idstein & Athey, 1984). In addition, the system covers wordprocessing, attendance, and recordkeeping. Originally a single user microcomputer was installed in each school but the district found it necessary to begin upgrading them to multi-user systems so that there were 2 or 3 workstations with have access to the same databases.

Figure 4. Example of a local area network.

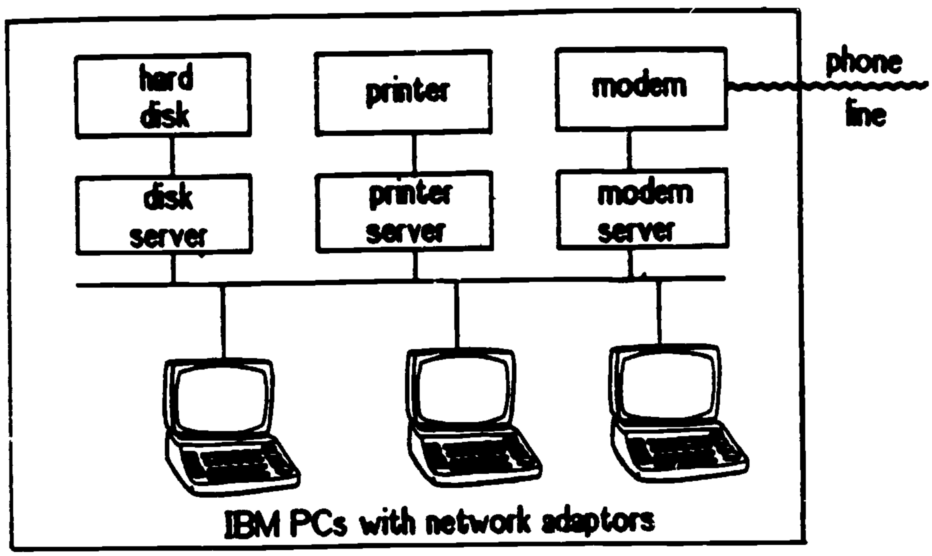
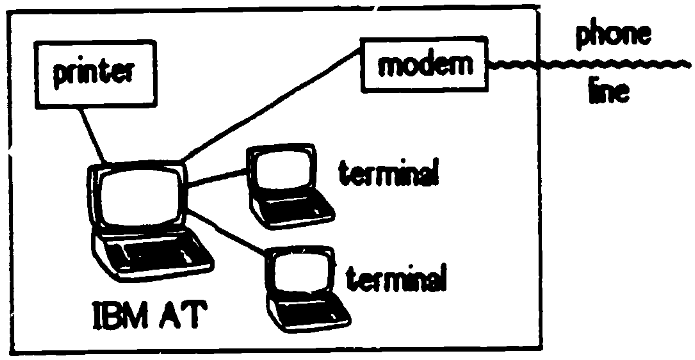


Figure 5. Example of a simple multi-user system.



Implications

Advantages:

- Inexpensive. One advantage of the multi-user system over a LAN is cost. Each workstation typically costs about $2,000. The cost of upgrading a single user microcomputer system by adding the second (dumb) terminal is about the same cost as purchasing a new single user system. The cost savings over single user systems only comes after the third or fourth terminal.

- User training. Idstein (1985) notes that users, particularly those accustomed to microcomputers, must learn to think of the whole system and not just the personal workstation. Resetting a personal computer to start a new program does no harm whereas resetting a multi-user system interrupts all users with annoying if not catastrophic results. Two users cannot query the same record or sort the student database at the same time.

Disadvantages:

- Software. The same software problems noted for LANs hold true for multi-user systems. Single user licenses make it illegal to run many packages on the multi-user system. Special database software is needed to support true simultaneous multi-user access to the same database.

III. COORDINATION AND SYSTEM DESIGN

There is little written about the problems of linking computers for educational applications. This is consistent with the current level of development. Linking is desired, but financial constraints have limited its application. Informal comments from participants in a national survey (Coe, 1985), and from others who have pioneered such applications, suggest a number of implementation issues, both for educational services and evaluation research.

It is appropriate to step back and reassess for a moment. Linking is a vehicle, not a solution. A good analytic framework is essential. An expensive, high performance local area network cannot save an instructional information system that is based on a shoddy mastery testing program, or inappropriate analysis of prerequisite skills. A researcher who cannot frame a proper evaluation question will not benefit from unlimited access to mainframe databases or microcomputer software.

McIsaac (1984) and Idstein (1985) cite the problem of educating administrators to think of whole systems rather than specific applications. When a district shifts from developing independent application programs to working in a database environment, the resulting system is more useful and more flexible. For example, a test scoring system developed in a database environment can do more than score tests, like add scores to a districtwide student database, or a school instructional information system.

Finding solutions to linking problems takes time and experimentation. Coe (1985) found that SEA and LEA attempts to link computers sometimes took a year or two to implement. The experience depended on the purpose of the application and for some districts the chosen linking approach was too extensive both in dollars and learning time in relation to their need.

Besides good methodologies, computer resources cannot be maximized without user acceptance. User acceptance and commitment is crucial to ensure good data quality and a high level of use. Hathaway (1985) notes that historically the flow of data has always been upward. He argues that distributed information systems will increase user acceptance, since instructionally useful data will be maintained at the school or classroom level for use at that level. Users at a higher level can then pick out the data they need.

Another way to promote user acceptance is to involve the users in each stage of the planning, design, and testing of the application. User involvement was a common recommendation from the managers of information systems in business settings in the literature reviewed by Craig and Banks (1985). The managers cited improvements in both the utility and acceptance when system developers sought input and reactions from end users. User training is necessary not only for application but system coordination. [Idstein (1985) lists unique training needs in implementing a multi-user system. Users, particularly those experiences with stand-alone microcomputers, had to learn to think of the effects of their actions on the system, not just their workstation.]

Coe (1985) noted that successful implementation at both state and district levels is coordination with data processing departments. Data processors will be in the role of supporting the growing number of desk top computers that are in the schools. Weil and Nace (1985) document this problem in the corporate world. Data processing in school districts has been historically dominated by business functions like payroll, inventory, and accounting. Second on the list came administrative functions like scheduling and attendance. Except for test scoring, evaluation activities have typically received a low priority from data processing departments. The response of data processing units to their larger role has been varied.

Craig and Banks (1985) suggest that training is not just for users. The programmers and analysts need to have training in the application before developing the software. The number of programs that have been scrapped because the programmer did not understand the application is shocking, but noone keeps such records.

Many large districts have highly departmentalized central staff, which often creates coordination problems. In one large western district, a data processing unit has responsibility for developing microcomputer based information systems, while an evaluation unit has responsibility for testing, and mainframing testing databases. By necessity, there will be considerable functional overlap. Good management should assist the cooperative efforts between the departments. Autonomous school administrations pose a similar problem. A large Northwestern district reported that the lack of a central database administrator has resulted in variations in the data collected, and the quality across buildings. In order to have a current and accurate database, one person needs to be assigned the responsibility for this task.

Considerable technical support will be needed to select, install, and troubleshoot communications hardware and software. The more sophisticated approaches like local area networking and synchronous communications require more support than other approaches. Past experience suggests that hardware and software vendors cannot be relied on to provide these services. Rather, local staff or outside contractors must be assigned to provide technical support.

When microcomputers are linked, the need for a person or group responsible for managing the system is very important. With stand-alone microcomputers, individual users could be responsible for scheduling time, makikng backup copies, ordering supplies, and other management duties. But in a linked system, a person must be designated as manager.

IV. CONCLUSIONS

In a recent article (Dressler and Syebold, 1985), two respected computer consultants speculating on the future of computing proposed the notion of supersystems. They projected a future with symbiotic linking of large and small computers.

> In the 1980s the desktop became the new battleground for all computer vendors; desktop computers and user-centered software are hailed as the wave of the future. Mainframes became the storage and transmission utilities. Computers moved out of the Industrial Age and into the Entrepreneurial Age.

Since much of the needed hardware and software is currently available, their predictions may be realized soon. Of course, education, strapped for resources to pay for the high startup costs, will lag behind the likes of GM and John Deere. Evaluation applications will likely constitute one of the forces to move educational agencies closer to truly integrated supersystems. Some of the evaluation applications that are already being implemented are:

- research projects requiring mainframe disk storage and processing speed to handle large files, but microcomputer software for manipulating summary data
- report production in agencies with both microcomputers and dedicated wordprocessing systems
- electronic mail, teleconferencing, and online database searches
- state or district data collection systems which allow the respondent to use the raw data or request summary data
- decentralized instructional information systems
- computerized test administration and scoring

There are many options available to link computers. A non-technical understanding of the characteristics of each helps guide planning efforts. Selecting the most appropriate approach depends on the nature of the application. Linking computers takes time and effort. There are technical problems to overcome, but these can often be solved or worked around. People problems are probably more significant and more difficult to deal with, and a wise administrator will know his staff well enough to realize that one system is likely to be more compatible and more productive than another.

The days of the personal microcomputer as an island are numbered. The pioneers in connecting computers admit to the problems and the frustrations, but generally they express no regrets for the time and effort because the results are so far-reaching.

REFERENCES

California State Department of Education (1984). IBM personal computer data entry system. Sacramento, CA.

Catchings, B. (November, 1984). A bridge between mainframes and micros. PC Magazine.

Coe, M. F. (1985). Applications of computers in LEA and SEA evaluation units (ROEP Paper and Report Series No. 109). Portland, OR: Northwest Regional Educational Laboratory.

Deck, D. D. (Spring, 1985). The import/export problem: Moving educational data between computers. Paper presented at the spring conference of the Washington Educational Research Association, Tacoma, WA.

Dressler, F., and Seybold, J. (July, 1983). Supersystems--a projection. Personal Computing.

Ferris, D. and Cunningham, J. (August, 1984). Local nets of micros. Datamation.

Hathaway, W. E. (February, 1985). Hopes and possibilities for educational information systms. Paper presented at a conference on Information Systems and School Improvement - Inventing the Future, Los Angeles, CA.

Idstein, P. (February, 1985). Let's create the future but let's keep it a secret. Paper presented at the UCLA Invitational Conference on Information for School Improvement, Los Angeles, CA.

Idstein, P. and Athey, P. ((October, 1984). The state of practice in local educational information systems: Early warnings from the front line. Paper presented at the joint meeting of the Evaluation Research Society and the Evaluation Network, San Francisco, CA.

Johnson, J. (1984). In search of missing links. Datamation.

Jordan, L. E., and Churchill, B. (1983). Communications and networking for the IBM PC. Bowie, Maryland: Robert J. Brady Publishing Company.

Kruglinski, D. (1984). Guide to IBM PC communications. Berkeley, CA: Osborne/McGraw-Hill.

Krumrey, A. (July, 1985). SNA strategies. PC Technical Journal.

McIsaac, D. M. (September/October, 1984). Managing school information systems. AEDS Monitor.

Moscow, D. K., Bolton, B.A., Olensky, S. (September/October, 1982). Student scheduling and tracking using the microcomputer. AEDS Monitor.

Piele, P. K. (1985). Local area networks in education: Overview, applications, and current limitations. Eugene, OR: University of Oregon, ERIC Clearinghouse on Educational Management.

Spain, T. (October, 1984). Networking: Pie in the sky or icing on the cake? Electronic Learning.

Sirota, W. (February, 1985). A new focus on data management. PC World.

Weil, B. and Nace, T. (February, 1985). Islands in the mainstream. PC World.

RECENT GUIDEBOOKS IN THIS SERIES

No.	Title
1	Microcomputers and Evaluation
2	Cost-Outcome Analysis: Measuring Costs
3	Microcomputers: Word Processing
4	Cost-Outcome Analysis: Measuring Outcomes
5	Microcomputers: Statistical Analysis Software
6	Investigative Journalism Techniques
7	Microcomputers: Data Base Management Software
8	Committee Hearings: Their Use in Evaluation
9	Microcomputers: Spreadsheet Software
10	Methods of Product Evaluation
11	Microcomputers: Instrument Generation Software
12	Evaluation Design: The Evaluator and the Architect
13	Microcomputers: Communication Software
14	Evaluation Design: Selecting Methods
15	Service Delivery Assessment Techniques
16	Cost-Outcome Analysis: Streamlining Techniques
17	Microcomputers: Software Evaluation
18	Criticism and Its Use in Evaluation
19	Evaluating Policy for District Computer Use
20	Narrative and Its Use in Evaluation

Printed by the Northwest Regional Educational Laboratory, a private nonprofit corporation. The work upon which this publication is based was performed pursuant to Contract No. 400-80-0105 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.

Research on Evaluation Program
Northwest Regional Educational Laboratory
300 S.W. Sixth Avenue
Portland, OR 97204